REMARKS

The invention is a method for modeling fluid flows in a fractured multiplayer porous medium to simulate interactions between pressure and flow rate variations in a well through the medium. The method discretizes the fractured medium by a mesh pattern with fracture meshes centered <u>on nodes at fracture intersections with each node being associated with a matrix volume</u>. Flows are determined between <u>each fracture mesh and the associated matrix volume</u> in a pseudosteady state.

The drawings stand objected to as set forth in Sections 2-3. Submitted herewith are new drawings which address the objections set forth in the PTO 948, which include complete text in the drawings for the letter designations "FM" which now appear as "fracture mesh", "CN" which now appears as "computing node", and "MB" which now appears as "matrix block" in Figs. 1 and 2.

The Examiner has objected to steps 10 and 12 of Fig. 5 and step 108 in Fig. 6 as being new matter. This assertion is traversed for the following reasons:

Step 10 "defining the fracture network" is supported in paragraphs [0021] and [0022] of the Substitute Specification under the heading "Fracture Network Discretization". The heading "Fracture Network Discretization" and the description therein suggests "defining the fractured network" as recited in step 10 and appears in the original disclosure.

Step 12 recites "defining the well" which is supported by "3: Well representation" as set forth in paragraphs [0035]-[0038] of the Substitute Specification. Defining the well is supported by "well representation" as appears in the original disclosure.

Step 108 "simulation results: pressure evolution of the well" is suggested by "c) Time Interval Management" as described in paragraphs [0052]-[0056] of the Substitute Specification and appears in the original disclosure. As may be seen, the terminology "pressure variation" is used in these paragraphs in association with time intervals. Moreover, differential pressure variation is described. This supports step 108.

In summary, steps 10, 12 and 108 respectively in Figs. 5 and 6 are fully supported by the original specification.

Since the Examiner has only objected to steps 10, 12, and 108 in Figs. 5 and 6, it is submitted that, in view of the foregoing explanation of the support for Figs. 5 and 6 in the original application, Figs. 5 and 6 and paragraphs [0064] and [0065] are supported and satisfy the Examiner's previous drawing requirement.

The Examiner objects to the amendment of June 12, 2003 as introducing new matter. This finding is traversed for the following reasons:

With respect to paragraph [0011] of the Substitute Specification, the Examiner is referred to the original specification where the same paragraph appears on lines 9-12 of page 2 of the original specification. Therefore, paragraph [0011] is not new matter. The original disclosure now in paragraph [0011] belongs in the Summary of the Invention.

Paragraph [0041] has been amended to delete material which the Examiner objects to as being new matter.

The original specification, under the headings "1) Fracture network discretization", "2) Matrix medium discretization", and "a Block geometry" teaches the calculation of volume. With respect to the original specification, the specification

teaches on page 7, lines 13-15, "[f]or calculation of these matrix volumes, the problem is dealt with layer by layer, which amounts to disregarding the vertical flows in relation to the horizontal flows in the matrix" and page 8 further teaches, in lines 17-20, "[a]ll of the pixels having the same fracture mesh number constitute the surface area of the matrix block associated with this mesh" and "[m]ultiplying this surface area by the height of the layer allows to obtain volume of the block associated with the mesh". It is therefore seen that the aforementioned portions of pages 7-9 of the original specification teach that the surface area of the mesh multiplied by the height is used for the determination of the volume.

The Declaration of Bernard Bourbiaux pursuant to 37 CFR §1.132 will be submitted as an expert opinion in early January to the effect that the specification as filed is enabling regarding volumetric calculation. Mr. Bourbiaux's Declaration will confirm the above arguments that the specification is enabling. A signed declaration cannot be obtained from Mr. Bourbiaux in view of the Assignee being closed for the holidays.

The Examiner objects to paragraphs [0064] and [0065] of the Substitute Specification. As matters are understood, the Examiner's objection was really with respect to the drawings allegedly introducing steps 10, 12 and 108 which the Examiner considered new matter. In view of the above response, it is submitted that the introduction of paragraphs [0064] and [0065] does not introduce new matter and is in fact responsive to Section 3-3 of the first Office Action where the Examiner required the illustration of the dynamic simulation solution algorithm as described in the specification.

Claim 9 has been amended to recite the subject matter of original claim 3. Accordingly, it is submitted that claim 9, as amended, does not introduce new matter.

The objection to claim 7 for reciting "a fractured multiplayer porous medium" has been corrected. The Examiner is thanked for pointing out the typographical error therein.

Claims 7-12 stand rejected under 35 U.S.C. §112, first paragraph, as containing subject matter which is allegedly not enabled. This ground of rejection is traversed for the following reasons.

The Examiner, in Section 7-1, maintains that the calculation of the pore volumes has not been disclosed in the specification. It is submitted that a person of ordinary skill in the art understands how to calculate pore volume given the disclosure on pages 7-9 of the original specification under the headings "1) Fracture network discretization, 2) Matrix medium discretization and 9) Block geometry" as discussed above and as will be considered in Mr. Boubiaux's Declaration. The description in the original specification describes the method of classic computation of volume which is area times height which is basic information to a person of ordinary skill in the art. Given the original disclosure's reference to "Simulation input data" including the statement in the first paragraph [0057] "[t]he geometry of the fractures network and the attributes of the fractures (conductively, opening) are given <u>in the form of a file</u> as in the method described in the aforementioned U.S. Patent 6,023,056", the calculation of volume does not involve undue experimentation as suggested by the Examiner in Section 7.1.

With respect to Section 7.2 of the Office Action, claim 9 has been amended to be consistent with original claim 3.

Claims 9 and 12 stand rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicant regards as the invention. Claim 9 has been amended to overcome the stated grounds of rejection.

Claims 7-8 and 10-11 stand rejected under 35 U.S.C. §103 as being unpatentable over GB 2 322 948 (Cacas et al) which corresponds to United States Patent 6,023,656 in view of Jones et al "Control-Volume Mixed Finite Element Methods" from Computational Geosciences. The Examiner reasons as follows:

> **11-1.** Regarding claims 7-8 and 10-11, Cacas et al. disclose a method for modelling fluid flows in a fractured multilayer porous medium to simulate interactions between pressure and flow rate variations in a well through the medium, comprising:
>
> discretizing the fractured medium by a mesh pattern with fracture meshes centered on nodes at fracture intersections (nodes, page 13, lines 10-15); and
>
> determining flows between each fracture mesh and the associated matrix volume in a pseudosteady state (transmissivity factor, page 15, lines 3-15; therefore, will be constant);
>
> the medium comprises fractured layers (fracture network, page 5, lines 3-6).
>
> However, Cacas et al. fail to expressly disclose:
>
> (1) each node being associated with a matrix volume;
>
> (2) the matrix volume associated with each fracture mesh in each layer of the porous medium contains all points which are closer to the corresponding node than to neighboring nodes;
>
> (3) determine a transmissivity value and the pressure varies linearly depending on a distance from a point being considered to the fracture mesh associated with the matrix block.
>
> Jones et al. disclose a control-volume mixed finite element method that provides a simple, systematic, easily implemented procedure for obtaining accurate velocity approximations on irregular block-centered grids because a key ingredient in simulation of flow in porous media is accurate determination of the velocities that drive the flow (abstract, page i). Specifically, Jones et al, disclose the missing elements:
>
> each node being associated with a matrix volume (With each

vertex, one associates a control volume, page 4, lines 40-42);

the matrix volume associated with each fracture mesh in each layer of the porous medium contains all points which are closer to the corresponding node than to neighboring nodes (control volume, usually found by taking the Voronoi volume bounded by the perpendicular bisectors of the sides of the triangles, page 4, lines 40-42);

determining at any point a transmissivity value for each pair of a fracture mesh and a matrix block by considering that pressure varies linearly depending on a distance from a point being considered to the fracture mesh associated with the matrix block (p is linearly interpolated from the vertices to the interior, page 4 line 42 through page 5, line l).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the teachings of Cacas et a!. to incorporate the teachings of Jones et al. to obtain the invention as specified in claims 7-8 and 10-ll because the control-volume mixed finite element method disclosed by Jones et al. provides a simple, systematic, easily implemented procedure for obtaining accurate velocity approximations that drive the flow in porous media (Jones, abstract, page i).

This ground of rejection is traversed for the following reasons.

The Examiner concludes that Cacas et al disclose determining flows between each fracture mesh and the associated matrix volume in a pseudo-steady state which is step b of claim 7. The Examiner is incorrect regarding Cacas et al. Cacas et al only disclose determining flows <u>between fracture meshes</u>. There is no disclosure in Cacas et al of determining flows between fracture meshes and the associated matrix volume in a pseudo-steady state. If the Examiner persists in this ground of rejection, it is requested that he point out on the record where his justification for reaching a conclusion that Cacas et al teach the second step of claim 7 may be found.

Cacas et al define a method for modelling fluid flows in a fractured multilayer porous medium to simulate interactions between pressure and flow rate variations in a well through the medium. Discretization of the fractured medium by a mesh

pattern by fracture meshes centered upon nodes at a fracture intersections is utilized. See column 5, lines 61-67, through column 6, lines 1-11 wherein each node is described as being at the middle of the intersection of segments. Moreover, column 6, lines 12, et seq. describe Calculation of Transmissivities. Those transmissivities are calculated for "each pair of connected nodes" which are the center of the nodes. Contrary to the Examiner's opinion, there is no disclosure of "determining flows between each fracture mesh and the associated matrix volume in a pseudo-steady state" with <u>transmissivity being only between nodes</u> which are the center of fracture meshes. See "b) Matrix-fracture transmissivity in paragraphs [0030]-[0034] of the Substitute Specification for a discussion of transmissivity <u>between a fracture mesh and a matrix block pair</u> in accordance with the present invention.

The Examiner relies upon Jones et al as disclosing a control-volume mixed finite element method that provides a simple, systematic, easily implemented procedure for obtaining accurate velocity approximations on a regular block-sensitive grid because a key ingredient in simulation of flow in porous media is an accurate determination of the velocities that drive the flow (Abstract, page i)." Jones et al describe a method for accurate velocity approximations of a regular block-centered grid.

Jones et al utilize the term "node" to identify the center of meshes. See the bottom of page 3, "Other methods for irregular grids" through the top of page 4 wherein the utilization of nodes is discussed. However, claim 7 recites, "discretizing the fracture medium by a mesh pattern with fracture meshes centered on nodes at fracture intersections with each node being associated with a matrix volume". The

mesh pattern with fracture meshes centered on nodes as recited in claim 7 has nothing to do with the "nodes" of Jones et al which are the center of meshes. Therefore, Jones et al's nodes centered at meshes, which are not associated with fracture meshes, would not motivate a person of ordinary skill in the art to modify Cacas et al. The nodes of Jones et al are non-analogous to the nodes of Cacas et al.

The text of Jones et al discloses a single medium or matrix and determines flows between matrix grid elements. In distinction, the claimed invention determines flows between each fracture mesh and the associated matrix volume with meshes being centered on nodes at fracture intersections. Jones et al pertains to a non-fractured medium and determines flows between matrix grid elements which are not flows between each fracture mesh and the associated matrix volume as set forth in claim 7 involving a fracture medium.

It is submitted that if the proposed combination of Cacas et al and Jones et al were made, the subject matter of claim 7 would not be achieved. Neither reference alone or in combination discloses the "determining flows between each fracture mesh and the associated matrix volume in a pseudo-steady state". Moreover, a person of ordinary skill in the art would not look to Jones et al to cure the deficiencies of Cacas et al since Jones et al do not pertain to determining flows in a fractured medium between each fracture mesh and the associated matrix in a pseudo-steady state and does not have nodes at fracture intersections.

Claims 10 and 11 respectively limit claims 7 and 8 in reciting determining at any point a transmissivity value for each pair of a fracture mesh and a matrix block by considering that pressure varies linearly depending on a distance from a point

being considered to the fracture mesh associated with the matrix block. The Examiner admits that Cacas et al do not teach this subject matter. However, the deficiencies of Jones et al, as not even pertaining to the claimed fracture meshes centered on nodes at fracture intersections associated with determining flows between each fracture mesh and the associated matrix volume in a pseudo-steady state, precludes Jones et al from suggesting to a person of ordinary skill in the art the subject matter of claims 10 and 11.

Claims 9 and 12 stand rejected under 35 U.S.C. §103 as being unpatentable over Cacas et al in view of Sarda et al as disclosed in United States Patent 6,064,944. With respect to claim 12, Sarda does not cure the deficiencies noted above with respect to claims 10 and 11. Specifically, Sarda does not suggest the deficiencies in the basic combination of Cacas et al and Jones et al regarding determining flows between each fracture mesh and the associated matrix volume in a pseudo-steady state. Accordingly, the subject matter of claim 12, which pertains to fracture meshes and a matrix block by considering that pressure varies linearly depending on a distance from a point being considered to the fracture meshes associated with the matrix block is not disclosed by Sarda et al.

In view of the foregoing amendments and remarks, it is submitted that each of the claims in the application is in condition for allowance. Accordingly, early allowance thereof is respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 C.F.R. §1.136. Please charge any shortage in fees due in connection with the

filing of this paper, including extension of time fees, to Deposit Account No. 01-2135 (612.37806X00) and please credit any excess fees to such Deposit Account.

Respectfully submitted,

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